

APPLICATION FOR
UNITED STATES PATENT

TO WHOM IT MAY CONCERN:

Be it known that I, Alexander L. Cheng, a citizen of the Republic of China (Taiwan), residing at 11 Springdale Avenue, White Plains, New York, 10604, have invented new and useful improvements in a:

METHOD AND APPARATUS FOR PARALLEL OPERATION IN A MULTIPLE ACCESS NETWORK

of which the following is a specification.

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METHOD AND APPARATUS FOR PARALLEL OPERATION IN A MULTIPLE ACCESS NETWORK

Field Of The Invention

The present invention pertains generally to multiple access communication systems, and more specifically to a method and apparatus for improving quality-of-service (QoS) of a multiple access network.

Background of The Invention

The communication protocol provides the rules for communication. The protocols govern the behavior of each communicating node on how to access the network, how to signal other nodes of its current situation and need, how to transfer data, and unique to a multiple access network, how to detect and resolve contention (often called collision). To help manage the complexity of a communication system, it is customary to divide the functionality of a communication system in layers of protocols. The International Standard Organization has specified seven layers from lower to higher: physical, media access control (MAC) or link, network, transport, session, presentation, and application layers. The present invention deals mostly with the physical layer for multiple channels and the MAC layer protocol for access. The management issue, including quality-of-service (QoS) policy, is a concern to be dealt with by the higher layer protocol. The bandwidth of communication network is normally separated into two types of channels--signaling and traffic bearer. In some multiple access networks, e.g. Carrier Sense Multiple Access with Collision Detect (CSMA/CD), these two types of channels are one and the same.

Communication systems with multiple access network have been providing satisfactory services in many markets, such as local area network (LAN), cellular telephony, and more recently broadband network based on CATV infrastructure. More recently, galvanized by the potential of a broadband network, cable modems conforming to CableLabs' Data Over Cable Service Interface Specification (DOCSIS) have been deployed in increasing numbers. These multiple access protocols provide satisfactory services when the network load is light (actually

these networks are considered unstable if the usage reaches 80% of the maximum network throughput). Even with a light network load, there is no guarantee of QoS in these multiple access networks. At the same time, there is increasing pressure to put time-sensitive services, such as voice and video, on these networks. Moreover, during contention resolution phase, the services are interrupted.

The present invention overcomes the aforementioned limitations with the following objects:

- Efficient and flexible use of communication facilities;
- Compatible with and complementary to existing protocols;
- Enabling various service quality levels; and
- Providing seamless growth path.

Further objects and advantages of the present invention will become apparent from a consideration of the drawings and ensuing description thereof.

Discussion Of Prior Art

CSMA/CD is detailed in IEEE 802 series specification. DOCSIS is published by CableLabs.

There have been a number of proposals to improve the efficiency of a multiple access network. U.S. Patent No. 5,235,592 provides a circuit-based capability to token-bus protocol. U.S. Patent No. 5,319,641 offers a higher priority data transfer capability to standard CSMA/CD type protocol. There are also proposals to augment the standard protocol with special device. U.S. Patent No. 5,740,174 uses repeater and expansion bus to improve communication capability, while U.S. Patent No. 5,940,399 uses multi-port repeater for arbitration. Unique radio frequency signals are used in U.S. Patent No. 5,657,326 for wireless implementation of standard multiple access protocol.

U.S. Patent No. 5,563,883 provides a method for communication in a multiple access network and a dynamic bandwidth-on-demand scheme. U.S. Patent No. 5,793,307 offers a hybrid limited contention and polling scheme with similar motivation.

U.S. Patent No. 5,742,239 discloses a method to assign time slots to nodes in a multiple access network for arbitration. When the traffic on the network is light, defined by no request of use for a predefined number of time slots, any node can access the network using a collision-detection method, thereby improving the system performance.

U.S. Patent No. 5,544,158 discloses a multiple access method using "multiburst." The number of channels are fixed and limited. More specifically, ISDN's 2B+D is used.

Summary of the Invention

The present invention discloses a method and apparatus for improving communication in a multiple access system, which comprises a plurality of communicating nodes and a communication facility linking these nodes. One of the nodes can be assigned as a controller for management and operation purposes. The communication facility is built so that it has more than one channel for communication among nodes. Each node is assigned a regular communication channel and a contention-resolution channel. In some cases, these two types of channels can be one and the same. In the case of U.S. Patent No. 5,563,883, the regular communication channel comprises the primary and secondary (backup) communication channels. The contention resolution channels can be assigned dynamically to communicating nodes based on network condition, node behavior, and QoS policy.

When a collision is detected by the communicating nodes, nodes engaged in the contention switch to the contention-resolution channel for contention resolution process while nodes not engaged in the contention continue their normal operation in the regular channel. After the contention is resolved and communication is accomplished, the nodes that have switched will switch back to their regular channel. Any nodes with existing protocol will simply stay on the regular channel and resolve the contention in the existing fashion. Therefore, backward compatibility is achieved.

Therefore, the benefits of the present invention are:

- Flexibility – dynamic allocation of channels for contention vs. fixed assignment;
- Efficiency - parallel operation for non-contending nodes to reduce down-time of network;

- Reduced group for contention resolution with parallel operation to speed up contention resolution process;
- Support of different service quality levels based on varying group size;
- Compatibility with existing protocol; and
- Smooth growth path for protocol and network facility.

Brief Description Of The Drawings

Figure 1 depicts a typical multiple access communication system.

Figure 2 illustrates logical flow diagram of communicating nodes.

Detailed Description Of The Preferred Embodiment

As illustrated in Figure 1, a plurality of nodes 10 are connected to a multiple access network 20, which is further divided into a plurality of communicating channels 30. In addition to the communication channel(s) of the physical layer protocol of an existing protocol, a plurality of communicating channels can be constructed using many different means, such as with separate time slots, different frequency band, coding scheme, separate physical media, or a combination of the above.

The allocation of these contention resolution channels can be performed dynamically based on the network condition and the capabilities of the communicating nodes. For example, when only a subset of the communicating nodes have access to a separate contention resolution channel, these nodes can use this contention resolution channel independent from the others for contention resolution process. Assignment of these contention resolution channels to the nodes can also be executed dynamically based on the network condition, resources available, network load, node behavior and QoS policy, etc.

Upon detection of a collision, nodes involved in the contention will switch to their assigned contention resolution channel. The contention-resolution protocol can be based on either a new protocol designed specifically for contention resolution or the original protocol, i.e., exponential back-off with random interval in the case of CSMA/CD, or contention polling

in case of U.S. Patent No. 5,563,883. The nodes not involved in the contention and the nodes not having implemented the contention resolution channel scheme will continue with their normal operation on the regular channel with the existing protocol. This method allows a backward compatibility for communication nodes using existing protocol while offering a smooth migration for enhanced implementation.

In the case of U.S. Patent No. 5,563,883, the improvement of the contention resolution process is from $\log_2 N$ to $\log_2 N/X$ given there are X spare contention-resolution channels, which are equally distributed to all N nodes, which have the same probability of engaging in a contention. Meanwhile, the regular traffic is not interrupted.

It should be noted that, given that the same protocol is used in both regular and contention-resolution channels and the communicating nodes sharing the same behavior pattern, the patented multiple access system exhibits the same behavior probabilistically in the worst case. The improvement of network performance is derived from either the separation of communicating nodes into smaller group, or improved channel characteristics, i.e., transmission speed and quality. The present invention enables more efficient communication in reasonably loaded network while offering facility to provide different QoS levels.

ANS *AN* From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of the invention. It should be understood that no limitation with respect to the specific structure and circuit arrangements illustrated is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Thus, in accordance with the invention, a Method and Apparatus for Parallel Operation In A Multiple Access Network has been provided accomplishing all of the objects, and having the features and advantages specified at the beginning of this specification. It is to be understood that the disclosed construction of the invention may be embodied in other forms within the scope of the claims.

What is claimed is: